

THE CACAO-POLLINATING MIDGES OF THE
FORCIPOMYIA ARGENTEOLA GROUP
(DIPTERA: CERATOPOGONIDAE)

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Abstract.—Diagnoses and keys are given for the *Forcipomyia argenteola* Group of species of the subgenus *Forcipomyia* s. str. Included in this group are *F. argenteola* Macfie from southern Brazil; *quatei* Wirth, ranging from the southern United States to southern Brazil; *calathea*, n. sp., from Brazil, Colombia, and Dominica; and *youngi*, n. sp., from Costa Rica, Ecuador, and Panama. Because of its close similarity to species of the *argenteola* Group, diagnostic notes are also given for the widespread Neotropical species, *squamitibia* Lutz. Larvae of species of the *argenteola* Group are commonly found in rotting banana stems, cacao pods, bracts of *Calathea* and *Heliconia*, and similar decaying vegetable matter; and the species are often abundant in cacao plantations where the adults may serve as pollinators.

Beginning with the classic work of Saunders (1956, 1959), intensive studies have been made on the immature stages and classification of the *Forcipomyia* midges associated with cacao culture. Although the smaller adults of the subgenera *Euprojoannisia* Brèthes, *Thyridomyia* Saunders, and *Warmkea* Saunders are most important in cacao pollination, the very abundance and ubiquity of the species of the subgenus *Forcipomyia* s. str. also place these midges high on the list of important cacao pollinators. Previous publications have reported on the taxonomy of all stages of *Euprojoannisia* (Saunders, 1956; Soria and Bystrak, 1975; Bystrak and Wirth, 1978); *Thyridomyia* (Saunders, 1956); and *Warmkea* (Wirth and Soria, 1980). Wirth and Soria (1975) described all stages of *Forcipomyia* (*Forcipomyia*) *genualis* (Loew) and a closely related species, *F. harpegonata* Wirth and Soria. Wirth (1976) described all stages of *F. (F.) pictoni* Macfie and two new closely related species from Florida, *F. seminole* Wirth and *F. beckae* Wirth.

The larval habitats of these *Forcipomyia* midges are somewhat correlated with their taxonomic group; the habitats of *Euprojoannisia* species are usually semiaquatic situations such as algae-covered rocks or mud, wet moss, or leaves, mats of decaying aquatic vegetation, and leaf axils of water-holding plants. Species of *Thyridomyia* usually are found in association with moss or algae in rather damp habitats. Immature stages of *Warmkea* species are frequently found in leaf axils of *Pandanus*, aroids and epiphytic and terrestrial bromeliads, and less often in rotting cacao leaves on the ground, in banana stems, and in bracts of *Heliconia*. Species of the subgenus *Forcipomyia* are less aquatic and are more commonly associated with rotting plant material, which in cacao plantations and their environs often involves heaps of cacao pods, old banana stems, cacao leaves, coconut debris, bracts of *Heliconia* and *Calathea*, and rotting fruits of coconut, calabash, palm nuts, etc.

Over the past few years I have received numerous samples of *Forcipomyia* midges closely resembling *F. argenteola* Macfie. Dr. Allen M. Young, working in Costa Rica, found them especially abundant in decaying sections of banana stems he set out in cacao plantations to attract ovipositing female midges and thus to sample the relative abundance of various ceratopogonid species. Although the adults of these species were almost indistinguishable from each other, larval and pupal characters were found to separate two distinct species in Costa Rica, neither of which proved to be *argenteola*. On closer study, adult characters were also discovered. A review of the material in the National Museum of Natural History, Smithsonian Institution, disclosed that there are at least four species in this group, closely related to *argenteola*. One species, *quatei* Wirth (1952), ranges from Florida and California to southern Brazil; *argenteola* apparently is restricted to southern Brazil; a third species, *calathea* n. sp., is recorded from Brazil, Colombia and Dominica; and the fourth, *youngi* n. sp., is found in Costa Rica, Ecuador, and Panama. In this paper I am presenting descriptions or diagnoses, figures, and a key for the separation of these species. Although it is not a member of the *argenteola* Group, *Forcipomyia squamitibia* Lutz adults are so similar to members of that group that a diagnosis is also presented for *squamitibia*.

A discussion of the taxonomic characters used in this paper can be found in the publications by Saunders (1924, 1956), Wirth (1952), Chan and LeRoux (1965), and Bystrak and Wirth (1978). Holotypes of the new species are deposited in the National Museum of Natural History, Smithsonian Institution, Washington, D.C.; paratypes will be deposited in the Museu de Zoologia, Universidade de São Paulo, Brazil, the British Museum (Natural History), London; the Muséum National d'Histoire Naturelle, Paris; the California Academy of Sciences, San Francisco; and the Milwaukee Public Museum, Milwaukee, Wisconsin.

I am greatly indebted to the following individuals and institutions for the submission of material and for their interest and efforts in collecting and rearing all stages of the most common *Forcipomyia* midges in American cacao plantations: The late Leslie G. Saunders, working in Costa Rica, Mexico, Puerto Rico, and Trinidad, with financial assistance from the American Cocoa Research Institute; Saulo de J. Soria, Centro de Pesquisas do Cacau, Itabuna, Bahia, Brazil; Eduardo J. Ureta S., Sanidad Agropecuaria, Dept. Antioquia, Medellín, Colombia; and Allen M. Young, Milwaukee Public Museum, Milwaukee, Wisconsin, working in Costa Rica under grants from the American Cocoa Research Institute.

Forcipomyia (Forcipomyia) argenteola Group

Diagnosis.—Legs yellowish, at most tarsi and apex of hindfemur infuscated; hindtarsal ratio 0.50–0.76; female wing brownish with one small yellowish spot at end of costa, base of costa sometimes yellowish; male wing usually extensively pale; male abdomen banded and genitalia yellowish with pattern of brownish infuscation; 3rd palpal segment swollen at base and bearing a deep round sensory organ; female tibiae without hastate spines; spermathecae ovoid, rather elongate, tapering to slender opening without elongate neck; male aedeagus poorly sclerotized, in form of an elongated shield, more than $1.5\times$ as long as basal breadth, with a submedian pair of faint longitudinal ridges; parameres with bases broadly fused, caudal processes moderately stout, each tapering to a sharp tip.

Larva hypognathous, typical of subgenus *Forcipomyia*; body yellowish white, without cuticular armature, head capsule brownish to blackish. Prothoracic pseudopods short and cleft a short distance, with 6–8 pairs of blackish hooks; posterior pseudopod with a double row of 16–20 brownish hooks. Head with *p* and *q* hairs long and curved or bent, slender or with tips slightly expanded. Body hairs *b* and *c* arising from a large conical common prominence; *a* hairs moderately long and distinctly hastate, their bases often connected across midline by a narrow blackish pigmented line; *b*, *c*, and *d* hairs elongate, usually microscopically fringed; *e* and *f* hairs moderately short to long, simple, *a*, *b*, and *e* hairs pale; *c*, *d*, and *f* hairs pigmented.

Pupa moderately stout; integument without conspicuous armature except for the usual 6 pairs of dorsal thoracic tubercles; abdomen sometimes with 1 or 2 pairs of elongate lateral processes and some inconspicuous spinose tubercles in transverse dorsal row on each segment. Prothoracic respiratory horn small to moderate in size, with short basal petiole, distal portion variably swollen in a rounded or globular knob bearing a row of 12–35 spiracular openings along apex and down dorsal side. Last abdominal segment drawn out in a pair of long tapering processes, at least twice as long as basal

breadth of segment. Last instar larval exuviae remain attached to posterior end of pupal abdomen.

KEY TO SPECIES OF THE *FORCIPOMYIA ARGENTEOLA* GROUP

1. Female tibiae with row of hastate spines on extensor surface; pale wing spot at end of costa larger, including most of 2nd radial cell; hindtarsal ratio 1.05; male parameres with slender common base *squamitibia* Lutz
- Female tibiae without hastate spines; pale wing spot smaller, not covering end of 2nd radial cell; hindtarsal ratio 0.50–0.76; male parameres with bases joined in a broad plate (*argenteola* Group) 2
2. Abdomen without broad dark brown scales; femora and tibiae without broad scales, entirely yellowish; halter slightly infuscated; hindtarsal ratio 0.72; female mandibular teeth vestigial; male parameres fused on proximal ½; larval head entirely dark brown *calatheae*, new species
- Abdomen with broad dark brown scales; femora and tibiae with some broad scales; hindtarsal ratio 0.42–0.56; apex of hindfemur pale or dark; mandible, male parameres, and larval head various (see below) 3
3. Hindfemur brownish on approximately distal ¼, this portion bearing broad brownish scales; mandibular teeth vestigial; 3rd palpal segment rather slender, swollen on proximal ½; halter infuscated *argenteola* Macfie
- Femora and tibiae entirely yellowish (hindfemur brown at tip in some *quatei*, in which case broad scales are pale); mandible with well developed teeth; halter pale or dark 4
4. Halter brownish; female mandible with about 20 small teeth; larval head unicolorous pale brown *quatei* Wirth
- Halter pale; female mandible with 12–15 strong teeth; larval head very dark brown toward mouth *youngi*, new species

KEY TO KNOWN LARVAE

1. Head hairs *p* and *q* swollen distally, not much longer than antenna; head pale brownish, dark only along oral margin; bases of dorsal body hairs not strongly pigmented *quatei* Wirth
- Head hairs *p* and *q* slender distally, more than twice as long as antenna; head dark brown, especially toward oral margin; bases of dorsal body hairs strongly pigmented 2
2. Head strongly pigmented, blackish on anterior ½ toward mouth; *e* and *f* hairs shorter than *c* and *d* hairs; *a* hair of last segment slender, not hastate distally *youngi*, new species

- Head unicolorous dark brown; *e* and *f* hairs much longer than *c* and *d* hairs; *a* hair of last segment hastate *calathea*, new species

KEY TO KNOWN PUPAE

1. Dorsal tubercles of thorax short and inconspicuous, not longer than basal breadth; respiratory horn with petiole stouter, bearing 30-35 spiracular openings in a much convoluted row; each abdominal segment with 2 pairs of lateral processes *calathea*, new species
 - Dorsal tubercles of thorax in form of elongate process at least twice as long as basal breadth; respiratory horn with slender petiole, bearing 12-25 spiracular openings; each body segment with 1 pair of lateral processes or with none 2
2. Respiratory horn slender, the slightly swollen apex with 12-15 spiracular openings; abdominal segments without conspicuous lateral processes; thoracic processes torchlike, the pair just behind level of respiratory horn with seta less than $\frac{1}{4}$ as long as process
 - *quatei* Wirth
 - Respiratory horn globular, with 20-25 spiracular openings; abdominal segments each with 1 pair of elongate lateral processes; dorsal thoracic processes between respiratory horns with apical seta about $\frac{1}{2}$ as long as process *youngi*, new species

Forcipomyia argenteola Macfie

Forcipomyia argenteola Macfie, 1939: 146 (♀; Brazil; fig. palpus, antenna, hindleg, radial cells, spermatheca); Lane, 1947: 163 (♂, larva, pupa; Brazil; fig. ♂ genitalia).

Female diagnosis.—Wing length 1.1-1.8 mm. Wing with a small yellow spot at end of costa; costal ratio 0.45. Halter pale brownish. Thorax brown, scutellum yellowish brown. Legs yellowish, hindfemur infuscated at apex, sometimes infuscation continued across knee to base of tibia; fore- and mid-femora sometimes slightly darker at tip, but this apparently due to more numerous, broad, striated, brownish scales there than elsewhere on legs; tarsi pale brownish; hindtarsal ratio 0.50-0.55. Palpus more slender than in related species; 3rd segment swollen on proximal $\frac{1}{2}$; palpal ratio 3.0. Proboscis longer than in related species; mandible with vestigial teeth. Abdomen with numerous dark brown, appressed, broad scales; penultimate segment yellowish; spermathecae ovoid, tapering to slender opening, without distinct necks.

Male diagnosis.—Wing length 1.5 mm. Coloration similar to that of female, dark area on hindfemur broader; wing pale brownish, veins slightly darker, dark brown on radial field, yellow spot at end of costa prominent; costal ratio 0.40. Hindtarsal ratio 0.42. Abdomen yellowish with prominent

dark brown segmental bands; genitalia similar to those of *F. youngi*, brownish except at base of 9th segment and on bases of basistyles, which are yellow.

Distribution.—Brazil.

Types.—Brazil, Santa Catarina, Nova Teutonia, 15.iii.1937, and 1.viii.1938, F. Plaumann, 2 ♀ syntypes (British Museum (Nat. Hist.)).

Specimens examined.—BRAZIL: Santa Catarina, Nova Teutonia, various dates, 1965–1971, F. Plaumann, 4 ♂, 7 ♀ (USNM).

Immature Stages.—I have not seen the immature stages of this species. Lane's (1947) descriptions of the larvae and pupae are brief and typical of the group. The pupal description as translated below is most diagnostic:

“*Pupa*. Respiratory tube constricted at the base, expanded and rounded toward the apex where it terminates in approximately 10 spiracles.

“Cephalothorax with the setae (anterior, dorsal, and marginal) small, smooth, and inserted on small mammillae; dorso-lateral tubercle conical, smooth and with a small smooth seta on the apex; dorsal tubercles conical, spiculose, and with blunt apices.

“Abdomen: Segments I to VII glabrous, VIII and IX spiculose, the spicules in the form of minute scales. Segments I to IV with the postero-marginal tubercles elongated, spiculose and from whose apex go off small smooth setae inserted on the middle of the lateral margin; in addition to these processes there are on the median portion other much smaller ones, likewise with smooth setae inserted on mammillae. Segment V like the preceding except for the postero-marginal tubercle which is defective. Segments VI and VII with the postero-marginal setae inserted on mammillae which are distinct, elongated, and uniform at the base, the apex transformed into a pennant, the internal much smaller than the external. Besides these setae there are discrete spicules. Segments VIII with only 2 setae like pennants. Last segment with apex blunt and the terminal filaments longer than the body of the segment.”

Forcipomyia calathea Wirth, NEW SPECIES

Fig. 1

A brownish species with pale yellow legs; wing dark brown with a small yellow spot at end of costa, male wing yellowish with dark brown macrotrichia over radial veins and infuscation over vein Cu_1 ; halter brown.

Female Holotype.—Wing length 1.18 mm; breadth 0.51 mm.

Head: Brown, with abundant long bristly brownish setae. Antenna (Fig. 1a) short, proximal segments moniliform; flagellar segments with lengths in proportion of 16-13-13-13-13-13-13-20-20-20-20-25, antennal ratio 1.00. Palpus (Fig. 1b) with lengths of segments in proportion of 9-11-30-13-12; 3rd segment moderately swollen on proximal $\frac{1}{2}$, bearing a deep sensory pit

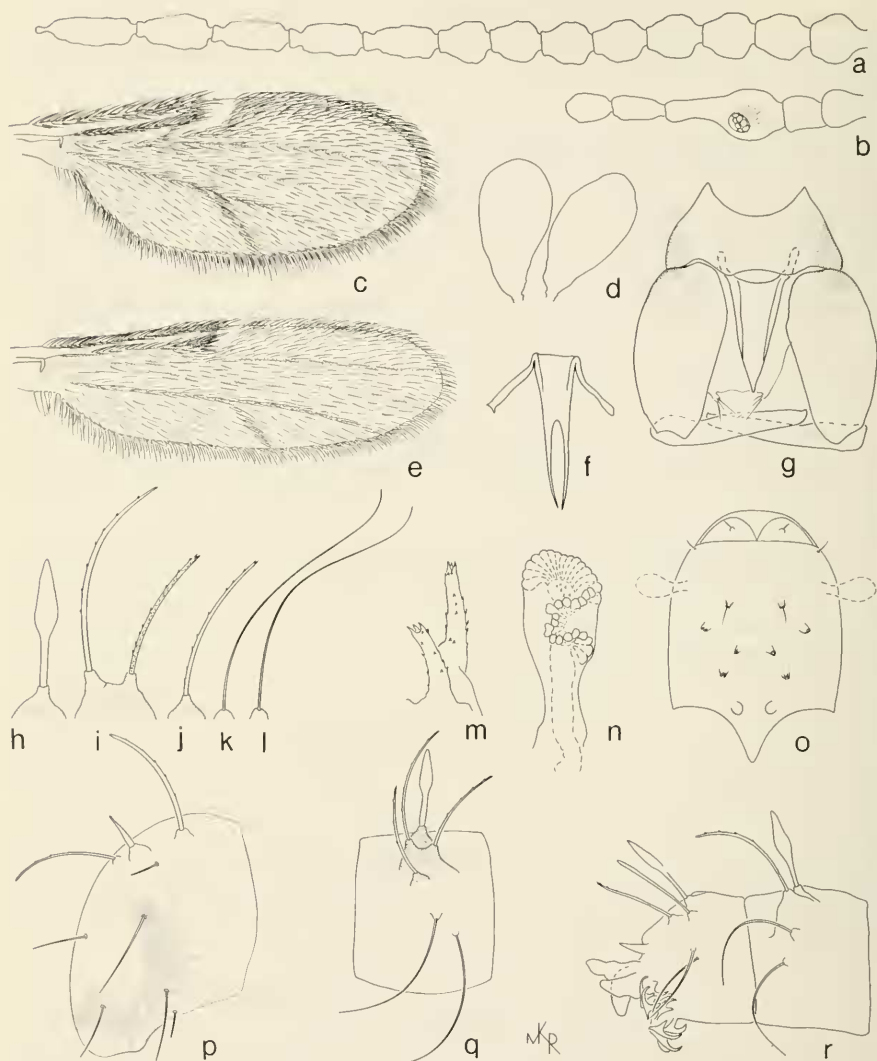


Fig. 1. *Forcipomyia calathea*. a-d, Female. e-g, Male. h-l, p-r, Larva. m-o, Pupa. a, Antenna. b, Palpus. c, e, Wing. d, Spermathecae. f, Parameres. g, Genitalia, parameres removed. h-l, a, b, d, c, e, f hairs respectively, of 2nd abdominal segment. m, Lateral processes of abdomen. n, Respiratory horn. o, Thoracic tubercles. p, Head, lateral view. q, Second abdominal segment, lateral view. r, Two posterior abdominal segments, lateral view.

opening by a slightly smaller pore; palpal ratio 2.1. Mandibular teeth vestigial.

Thorax: Brown; mesonotum and scutellum with long bristly hairs and shorter finer setae. Legs unicolorous yellowish with brownish tinge due to numerous flattened, narrow appressed scales; tarsi concolorous with tibiae; femora and tibiae stout, tibiae with longest bristly hairs on extensor surface about $3\times$ diameter of tibia; hindtibial spur short and inconspicuous, pointed, about $\frac{1}{2}$ as long as diameter of tibia. Tarsi with ventral palisade setae prominent on tarsomeres 1 and 2 of fore- and midlegs, poorly developed on hindleg; some stronger dark ventral spines scattered on tarsomeres 1 and 2 of hindlegs, apical only on remaining tarsomeres 1-4. Tarsal ratios 1.00 on foreleg, 0.70 on midleg, and 0.76 on hindleg. Wing (Fig. 1c) brown, darker anteriorly, with dense, long, brown macrotrichia, a small yellow spot at end of costa; costal ratio 0.44. Halter brown.

Abdomen: Brown, last 2 segments and cerci paler; vestiture of rather short brown hairs, those on pleura less conspicuous; terga with some narrow brown scales. Spermathecae (Fig. 1d) 2, dark brown, elongate ovoid, tapering gradually to slender opening to duct; subequal, each measuring 0.087 by 0.043 mm.

Male allotype.—Wing length 1.37 mm; breadth 0.40 mm. Similar to female with usual sexual differences. General color as in female, but wing (Fig. 1e) pale yellowish brown, slightly darker anteriorly and a line along vein Cu_1 , costal and radial veins dark brown due to prominent long slender, scalelike macrotrichia. Abdomen with broad brown segmental bands bearing long yellowish to brown, bristly setae. Costal ratio 0.42; tarsal ratios 0.82 on foreleg, 0.65 on midleg, and 0.72 on hindleg.

Genitalia (Fig. 1g): Basistyle and distal part of 9th segment brown, dististyle and midportion of 9th sternum pale. Aedeagus elongate, nearly triangular, about $2\times$ as long as basal breadth, poorly sclerotized, apex narrowly pointed. Parameres (Fig. 1f) poorly sclerotized, yellowish bases fused for $\frac{1}{2}$ the total length of parameres, the caudomedian emargination forming an acute angle; caudal processes slender with sharp-pointed apices.

Pupa.—Length 2.5-3.0 mm. Color brownish, abdomen paler. Respiratory horn (Fig. 1n) on distinct stalk, the distal portion 1.5-2 \times as broad as stalk depending on angle viewed, and about as long as stalked portion; bearing about 30-35 spiracular openings in a single, much convoluted row around apex and partway down dorsal side of swollen portion. Thoracic tubercles (Fig. 1o) low and conical, bearing a fine seta or fine spicules as figured. Each abdominal segment (Fig. 1m) with 2 pairs of spiculate lateral processes, their apices with several short spines.

Larva.—Length 4-5 mm when mature. Color yellowish white; head capsule (Fig. 1p) uniformly brownish; dorsal body hairs borne on prominent

dark brown conical prominences as figured (Fig. 1q). Hairs *p* and *q* of head long and slender, of uniform width to tip, pale yellowish. Body hairs *a*, *b*, and *e* pale, *c*, *d* and *f* brownish (Figs. 1h-l); *b* and *d* hairs arising from a common tubercle. Last 2 segments as in Fig. 1r. In mature larvae and larval exuviae, the *a* hairs connected across midline by a slender black sclerotized line; *a* hair on last segment not so broadened subapically, with margins microscopically and sparsely serrate. Cuticular armature absent. Prothoracic pseudopod cleft apically, each lobe with 6-7 brown hooks; posterior pseudopod with a row of 16-20 brown hooks; anal blood gills bilobed.

Distribution.—Brazil, Colombia, Dominica.

Types.—Holotype ♀, allotype ♂, Dominica, Calabishie, swamp at mouth of Hodges River, 27.ii.1965, W.W. Wirth, reared from bracts of *Calathea lutea* (Type no. 76582, USNM). Paratypes, 22 ♂, 24 ♀, as follows: DOMINICA: Same data as types, 8 ♂, 6 ♀, with associated larval and pupal exuviae, 3 larvae. BRAZIL: Santa Catarina, Nova Teutonia, various dates 1961-1970, F. Plaumann, 14 ♂, 18 ♀.

Other material examined.—BRAZIL: Bahia, Ilheus, Itabuna, 24.x.1977, S. J. Soria, reared from sugar cane leaf axils, 1 ♂ with pupal exuviae, 4 larvae. COLOMBIA: Antioquia, San Jeronimo, 17.i.1974, E. Urueta, reared from decaying papaya stem, 2 ♂, 3 ♀, 1 pupa, 2 larvae.

Discussion.—The species takes its name from the plant from which the type-series was reared in Dominica. *Forcipomyia calathea* is distinguished from the other species in this group by rather negative characters: The vestigial mandibular teeth; lack of hastate spines on the female tibiae; narrow rather than broad scales on the abdominal terga and legs; the uniformly dark brown larval head; the large pupal respiratory horns with long, more or less convoluted, line of spiracular openings; and the short dorsal tubercles on the pupal cephalothorax.

Forcipomyia quatei Wirth

Fig. 2

Forcipomyia quatei Wirth, 1952: 142 (♂, ♀; Calif.; fig. ♂ genitalia).

A pale brown species with yellowish legs; wing dark brown with a small yellow spot at end of costa; abdomen with conspicuous clumps of broad striated blackish scales on pleural segments; halter brown.

Female.—Wing length 1.15 mm; breadth 0.48 mm.

Head: Brown including antenna and palpus. Antenna (Fig. 2a) with lengths of flagellar segments in proportion of 15-11-11-12-12-11-11-11-24-25-27-28-33; antennal ratio 1.45. Palpus (Fig. 2b) with lengths of segments in proportion of 7-13-29-10-10; 3rd segment broad and evenly swollen on proximal ½, abruptly tapering to slender tip past the sensory pit, palpal ratio 2.0; sensory pit 2× as deep as diameter of pore opening, which is slightly

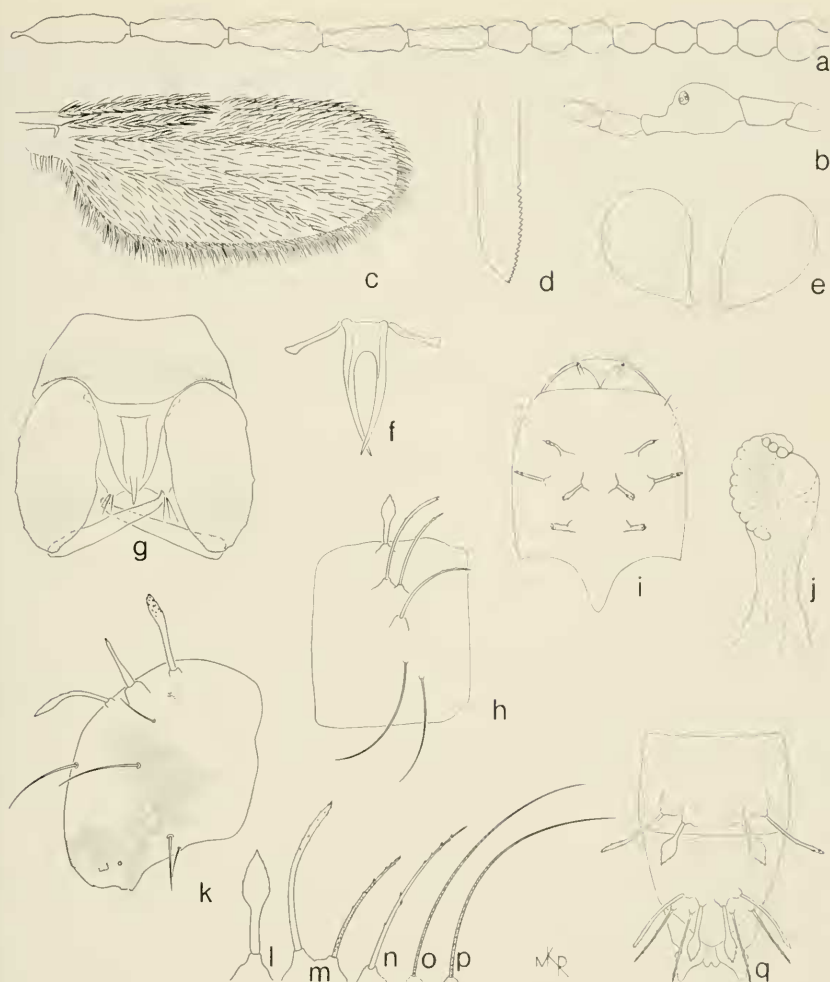


Fig. 2. *Forcipomyia quatei*. a-e, Female. f-g, Male. h, k-q, Larva. i-j, Pupa. a. Antenna. b. Palpus. c. Wing. d. Mandible. e. Spermathecae. f. Parameres. g. Genitalia, parameres removed. h. Second abdominal segment, lateral view. i. Thoracic tubercles. j. Respiratory horn. k. Head, lateral view. l-p. a, b, d, c, e, f hairs respectively, of 2nd abdominal segment. q. Two posterior abdominal segments, dorsal view.

less than diameter of pit. Mandible (Fig. 2d) with 21 small teeth, their size slightly increasing proximad in series.

Thorax: Brown; mesonotum and scutellum dark brown, with abundant mixture of long bristly hairs and shorter, fine, somewhat flattened hairs. Legs bright yellow, tarsi and narrow apex of hindfemur brownish; knees,

foretibia, and all of tarsi appearing shaggy due to abundant vestiture of broad, striated brown scales; tibiae with long extensor bristles, as long as $4\times$ diameter of tibia on hindleg. Hindtibial spur yellowish, inconspicuous, length less than apical breadth of tibia; tarsomeres 1 and 2 with ventral row of palisade setae, prominent only on foreleg; some long, rather slender ventral spines apically and subapically on tarsomeres 1-4 on mid- and hindlegs, poorly developed on foreleg. Tarsal ratios 0.54 on foreleg, 0.49 on midleg, and 0.56 on hindleg. Claws slender and curved, empodium well developed. Wing (Fig. 2c) brownish, with abundant brownish long decumbent macrotrichia, more prominent along veins, a small yellowish spot formed by yellowish scales at end of costa; veins in radial field appearing much darker due to abundant flattened broad striated scales; costal ratio 0.44. Halter brownish.

Abdomen: Brown; covered with broad flattened brown scales, pleura appearing blackish due to prominent clumps of such scales; cerci yellowish. Spermathecae (Fig. 2e) 2, dark brown, ovoid, tapering gradually to slender opening to duct; subequal, each measuring 0.081 by 0.032 mm.

Male.—Wing length 1.39 mm; breadth 0.45 mm. Similar to female with usual sexual differences. General color as in female, but wing appearing slightly paler brown between veins due to sparser vestiture of longer narrower macrotrichia; abdomen yellow with segmental banding of brown integumental color plus abundant broad, flattened, dark brown, appressed scales. Antennal segments 12-15 with lengths in proportion of 42-45-50-50; 3rd palpal segment not as broadly swollen on proximal $\frac{1}{2}$, palpal ratio 2.5; costal ratio 0.44; tarsal ratios 0.45 on foreleg, 0.53 on midleg, and 0.55 on hindleg.

Genitalia (Fig. 2g): Short and broad; dark brown, yellowish on proximal halves of basistyles, proximal halves of dististyles, and proximal portion of 9th segment; with abundant vestiture of long bristly yellowish hairs and broad, flattened, moderately long, striated, dark brown scales. Aedeagus shield-shaped as usual in the subgenus, slightly longer than basal breadth, without basal arch, tip with a slender, pointed process, and with a pair of faint, linear, submedian internal ribs. Parameres (Fig. 2f) with bases joined in a broad basal portion extending to $\frac{1}{4}$ of total length, the caudal processes rather stout and swordlike with pointed apices.

Pupa.—Length 2.7-2.8 mm. Color of exuviae pale yellowish. Respiratory horn (Fig. 2j) slender, with distinct petiole on proximal $\frac{1}{2}$; apex rounded with 12-15 spiracular openings in a row at apex and down posterior side, the anterior margin of distal portion carinate and meeting proximal end of 1st spiracle as figured. Thoracic tubercles (Fig. 2i) elongated, stalklike, the anterior 2 pairs each bearing a short slender seta, the other 3 pairs bearing numerous spinules on distal halves. Abdomen without conspicuous lateral processes.

Larva.—Length 4–5 mm when mature. Color yellowish white; head capsule pale brownish, somewhat darker around oral margin; prominences at bases of body hairs not strongly pigmented. Hairs *p* and *q* of head (Fig. 2k) slightly bent forward, thickened and microscopically spiculose on distal halves. Body hairs *a–f* as in Figs. 2h and 2l–p. Last 2 body segments as in Fig. 2q, the *a* hair of last segment hastate and only slightly longer than those on preceding segments; anal blood gills short, bilobed. Cuticular armature absent. Prothoracic pseudopod cleft apically, each lobe with 7–8 slender black hooks; posterior pseudopod with a row of 16–20 brown hooks.

Distribution.—USA (California, Louisiana, Florida), Dominica, Belize, Costa Rica, Panama, Ecuador, Brazil.

Types.—Holotype ♂, Bakersfield, Kern Co., California, vii.1946, B. Brookmam (Type no. 60929, USNM). Allotype and 2 paratypes, Kern Co., California.

Specimens examined.—All from light traps unless otherwise noted. BELIZE: Hummingbird Hershey, viii.1981, A. M. Young, from cacao pods, 10 ♂, 9 ♀. BRAZIL: Bahia, Itabuna, iv.1971, J. Winder 1 ♂; same, 1973, reared from cacao pods, 1 ♂; from emergence traps, 6 ♂, 6 ♀. COSTA RICA: Heredia Prov., La Virgen, Finca La Tigra, 19.ix.1979, A. Young, ex banana stem, 4 larvae, 10 pupae. Limon Prov., Finca La Lola near Siquirres, ex banana stems, Young, ii.1981, 2 ♂, 4 ♀, 9 larvae, 8 pupae; viii.1981, 3 ♂, 3 ♀, 2 larvae, 4 pupae. DOMINICA: Clarke Hall, 28.i.1965, W. W. Wirth, reared from banana stem, 7 ♂, 1 ♀, 4 larvae, 4 pupal exuviae (specimens figured). ECUADOR: Pichilingue (INIAP), iv.1978, reared from rotting log, J. Mendoza no. 13, 8 ♂, 1 ♀. PANAMA: Canal Zone near Arraijan, monsoon forest, *Spondias* tree canopy, 23.vii.1979, E. Broadhead, 1 ♂. USA: Florida: Alachua Co., Gainesville, iv.1967, F. S. Blanton, 1 ♂; 18.xi.1969, F. W. Mead, 1 ♀. Collier Co., Collier Seminole St. Park, 17.v.1973, Wirth, 1 ♂, 4 ♀. Escambia Co., Molina, 12.viii.1969, Blanton, 2 ♂; Walnut Hill, vi.1969, Blanton, 1 ♂. Jackson Co., Florida Caverns St. Park, 26.v.1973, Wirth, 5 ♂. Jefferson Co., Monticello ix.1969, W. H. Whitcomb, 5 ♂, 4 ♀. Lee Co., Sanibel Island, 11.v.1973, Wirth, 1 ♂, 3 ♀. Leon Co., 3 mi. N. Tallahassee, v.1970, Blanton, 2 ♀. Liberty Co., Torreya St. Park, 15.v.1971, G. B. Fairchild, 1 ♂. Monroe Co., Big Pine Key, 10.iv.1970, Wirth, 13 ♂, 15 ♀. Orange Co., Lake Magnolia Park, 6.viii.1970, E. Irons, 1 ♀. Putnam Co., Lon's Lake, v.1971, Blanton, 3 ♂, 18 ♀. Sarasota Co., Myakka River St. Park, 21.v.1973, Wirth, 1 ♀. Louisiana: E. Baton Rouge Parish, Baton Rouge, University Campus, v.1947, Wirth, 1 ♀.

Forcipomyia (Forcipomyia) youngi Wirth, NEW SPECIES

A brown species with banded abdomen and pale yellow legs; wing in both sexes dark brown with a small yellow spot at end of costa and a clump of

yellow scales at base of costa; abdomen with segmental bands of broad striated blackish scales and pleura with additional mixture of golden scales; tibia with broad brown scales; halter pale.

Holotype female.—Wing length 1.48 mm; breadth 0.60 mm.

Head (Fig. 3i): Brown, with abundant blackish, long, bristly setae on vertex, clypeus, and first 2 antennal segments. Antenna (Fig. 3a) with segments 3–10 yellow, 11–15 pale brown; lengths of flagellar segments in proportion of 16-12-13-13-13-13-13-33-33-33-32-44; antennal ratio 1.50. Palpus (Fig. 3b) dark brown; lengths of segments in proportion of 10-14-30-14-13; 3rd segment swollen on proximal $\frac{2}{3}$, bearing a deep sensory pit opening by a slightly smaller pore; palpal ratio 1.9. Mandible with 11 coarse teeth, the proximal teeth larger.

Thorax: Mesonotum, scutellum and postscutellum dark brown, pleuron yellowish with some pale brown areas; mesonotum with long bristly hairs and shorter finer setae; scutellum with numerous long bristly setae. Legs bright yellow, tarsi pale brownish; tibiae with vestiture of short, broad, appressed, striated brown scales; tarsi with similar scales more numerous but more slender, scales at narrow apices of tarsomeres golden; tibiae with numerous long yellowish extensor bristles, the longest on hindtibia as long as $5\times$ diameter of tibia; hindtibial spur yellowish, slender, pointed, about as long as apical breadth of tibia. Tarsi with ventral palisade setae in one row, prominent and spinelike on tarsomeres 1 and 2 of foreleg, poorly developed on mid- and hindlegs; some stronger dark ventral spines scattered on tarsomeres 1 and 2 of mid- and hindlegs, apical only on tarsomeres 1 and 2 of foreleg and on tarsomeres 3 and 4 of all legs. Tarsal ratios 0.58 on foreleg, 0.52 on midleg, and 0.54 on hindleg. Wing (Fig. 3c) brown, darker anteriorly and along veins due to denser vestiture of long black macrotrichia; a small yellow spot at end of costa and a clump of yellow scales on costa at wing base; long, narrow, dark scales on costa and over radial field shaped as in Fig. 3g; costal ratio 0.48. Halter pale.

Abdomen: Dark brown, last 2 segments and cerci yellowish; densely covered dorsally and ventrally with moderately long and broad, flattened, striated, dark brown scales; pleura with similar scales but golden yellow in color; last tergum with long bristly yellow hairs. Spermathecae (Fig. 3h) 2, dark brown, elongate ovoid, tapering gradually to slender opening to duct; subequal, each measuring 0.104 by 0.054 mm.

Male allotype.—Wing length 1.44 mm; breadth 0.50 mm. Similar to female with usual sexual differences. General color as in female, but wing with costa yellowish and bearing yellow scales on proximal $\frac{1}{2}$; abdomen yellow below and brown above, each tergum with a line of brown infuscation following the bases of the long bristly hairs across midlength of tergum. Antennal segments 12–15 with lengths in proportion of 63-48-40-47; 3rd palpal

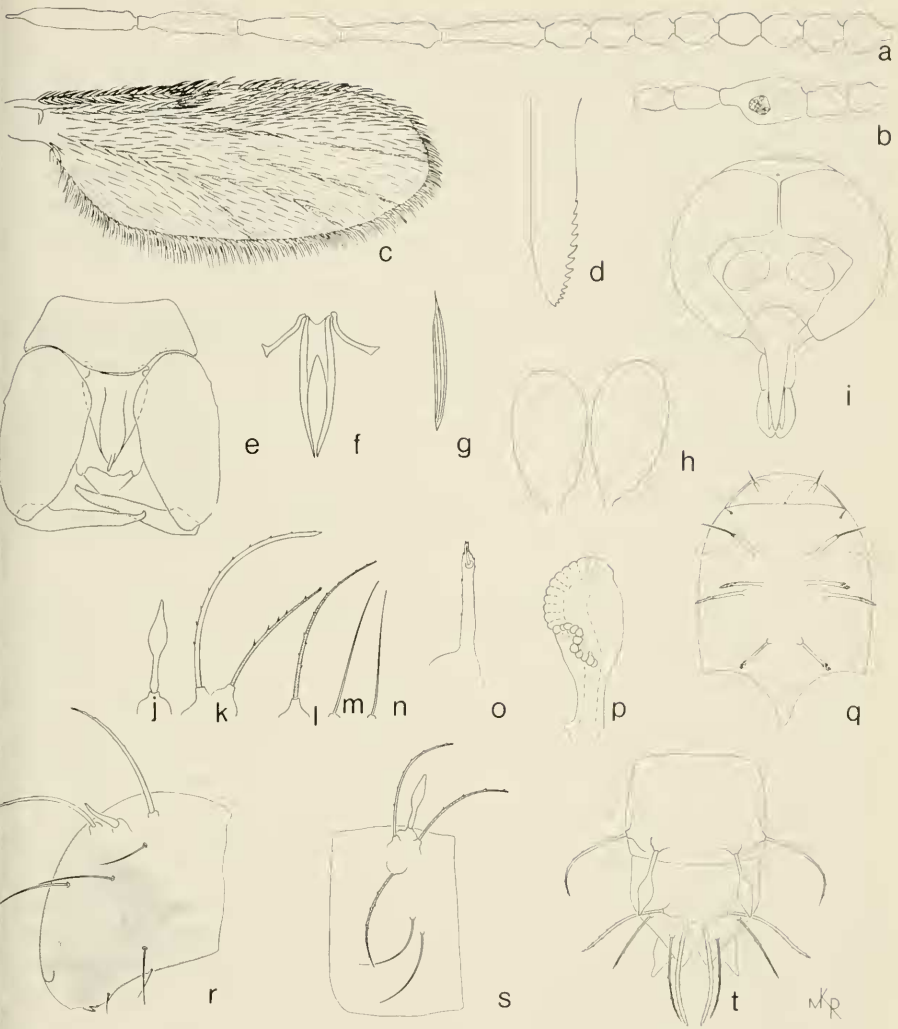


Fig. 3. *Forcipomyia youngi*. a-d, g-i, Female. e-f, Male. j-n, r-t, Larva. o-q, Pupa. a, Antenna. b, Palpus. c, Wing. d, Mandible. e, Genitalia, parameres removed. f, Parameres. g, Scalelike macrotrichia from wing. h, Spermathecae. i, Head, anterior view. j-n, a, b, d, c, e, f hairs, respectively, of 2nd abdominal segment. o, Lateral processes of abdomen. p, Respiratory horn. q, Thoracic tubercles. r, Head, lateral view. s, Second abdominal segment, lateral view. t, Two posterior abdominal segments, dorsal view.

segment not as swollen as in female, palpal ratio 2.3. Costal ratio 0.45; tarsal ratios 0.57 on foreleg, 0.47 on midleg, and 0.56 on hindleg.

Genitalia (Fig. 3e): Slightly longer than broad; moderately brown infuscated except at bases of 9th segment, basistyles, and dististyles. Aedeagus almost hyaline, with rather narrow base, about $1.5\times$ as long as basal breadth, tip with slender process. Parameres (Fig. 3f) poorly sclerotized, yellowish, basal portion fused for about $\frac{1}{4}$ of total length, the caudomedian emargination narrow and pointed, distal processes rather stout and sword-like with pointed apices.

Pupa.—Length 2.8–3.0 mm. Color pale brownish. Respiratory horn (Fig. 3p) short and globular, with short slender petiole; swollen distal portion with a row of 20–25 spiracular openings around apex and a slightly undulating row down posterior side of swollen portion. Thoracic tubercles (Fig. 3q) greatly elongated and slender, the anterior 2 pairs each bearing a long slender seta about as long as tubercle itself, the posterior 3 pairs with apices finely and densely spinulose. Each abdominal segment (Fig. 3o) with a pair of elongate lateral processes, each process with spinulose tip and a subapical seta.

Larva.—Length 5–6 mm when mature. Color yellowish white; head capsule (Fig. 3r) brown, becoming conspicuously blackish toward oral margin; conical prominences at bases of dorsal body hairs moderately brownish pigmented; *a* hairs connected across dorsum of each body segment by a conspicuous narrow line of blackish pigment. Hairs *p* and *q* of head (Fig. 3r) long and slender, pale, of uniform width to tip, and sparsely fringed with microscopic spinules. Body hairs *a*, *b*, and *e* hyaline, *c*, *d*, and *f* dark brown; hairs *b*, *c*, and *d* with fringe of short, coarse spinules as figured. Last 2 body segments as in Fig. 3t, the 4 *a* and *b* hairs on last segment arising from a common sclerotized plate, the *a* hairs long and slender, only slightly flattened and expanded, and bearing fringing spinules; anal blood gills comparatively slender, apparently undivided. Cuticular armature absent. Prothoracic pseudopod short and only slightly cleft, each lobe with 6–8 blackish hooks; posterior pseudopod with a row of 18–20 blackish hooks.

Distribution.—Costa Rica, Ecuador, Panama.

Types.—Holotype ♀, allotype ♂, Panama, Canal Zone, Gamboa, Pipeline Road, vii.1967, W. and M. Wirth, reared from rotting bracts of *Heliconia mariae* (Type no. 76583, USNM). Paratypes, 29 ♂, 28 ♀, 20 larvae, 24 pupae, as follows: COSTA RICA: Limon Prov., Finca La Lola, ii.1981, 7 ♂, 10 ♀, 6 larvae, 10 pupae; same, but viii.81, 3 ♂, 6 ♀, 3 larvae, 3 pupae; same, but 9–11.xi.1980, ex rotten cacao pods, 1 ♂. Siquirres, 29.v.1956, L. G. Saunders, reared from cacao pods and tree bark, 1 ♂, 2 ♀, 3 larvae; same but 6.vi.1956, reared from cacao pods, 5 ♂, 5 ♀, 3 larvae. Cartago Prov., Turrialba, CATIE, 24.vi.1980, A. Young, 1 ♂ and pupal exuviae.

Heredia Prov., La Virgen, Finca El Uno, 19.ix.1979, A. Young, ex banana stem, 1 larva, 6 pupae. ECUADOR: Quevado, Pichilingue, INIAP, iv.1978, J. Mendoza, reared from rotting vegetation, 8 ♂, 1 ♀. PANAMA: Same data as types, 3 ♂, 4 ♀, 4 larvae, 5 pupae.

Discussion.—This species is named for Dr. Allen Young, Milwaukee Public Museum, in appreciation of his interest and his studies on the biology of Costa Rican ceratopogonid cacao pollinators.

Forcipomyia youngi is easily recognized by its enlarged female mandibular teeth, and by the very broad, short, flattened, blackish scales on the tibiae. The larva has the head pale posteriorly and dark brown towards the mouth, and the pupa is distinguished by the elongate thoracic tubercles with long apical setae.

Because of its close external similarity with species of the *argenteola* Group, the following diagnosis and discussion are presented for *Forcipomyia squamitibia* Lutz.

Forcipomyia squamitibia Lutz

Forcipomyia squamitibia Lutz, 1914: 88 (♀; Brazil; fig. wing, leg); Macfie, 1939: 145 (♀ redescribed; Brazil; fig. antenna, palpus, tibial spine; radial cells, spermatheca); Macfie, 1949: 111 (♂ described; Mexico; fig. parameres).

Female (measurements from a female from Nova Teutonia, Brazil):—Wing length 1.30 mm; breadth 0.80 mm. A brown species with yellowish legs; antenna pale brown; last 2 abdominal segments and cerci yellowish. Wing dark brown, darker along anterior margin and along veins; a rather large yellow spot covering most of 2nd radial cell and slightly distad on anterior wing margin; costal ratio 0.44. Halter slightly infuscated. Antennal segments short and vasiform, antennal ratio 0.80. Palpus with 3rd segment moderately swollen on proximal ½, with a small deep sensory pit; palpal ratio 2.2. Mandibular teeth vestigial. Body, legs, and abdomen without broad flattened scales, long narrow scales on abdominal terga. Tibiae with slender, pointed hastate spines in extensor series. Tarsal ratios 1.05 on foreleg, 1.06 on midleg, and 1.08 on hindleg. Spermathecae 2, oval to ovoid, slightly tapering to short slender neck; slightly unequal, measuring 0.101 by 0.058 mm and 0.087 by 0.057 mm.

Male.—Similar to female with usual sexual differences. Tibiae without hastate spines. Wing yellowish, anterior margin with large yellow spot over tip of 2nd radial cell, preceded by a strip of dark brown scalelike macrotrichia over costal and radial veins and followed by a prominent quadrate patch of dark brown scales; a dark brown line along vein Cu_1 . Abdomen with prominent brown segmental bands giving rise to long golden to brownish, bristly hairs; no broad flattened scales. Genitalia with 9th segment

brown, basistyles and dististyles yellowish; aedeagus shield-shaped, slightly longer than basal breadth, caudal apex pointed; parameres a pair of long processes, rodlike at bases and tapering to filamentous tips, their bases fused only a short distance in a rather narrow common base (as figured by Macfie, 1949).

Distribution.—Brazil to Mexico.

Types.—An unspecified number of syntypes, Manguinhos, Brazil, Lutz collection, common at lights with other marine species (Inst. Oswaldo Cruz, Rio de Janeiro).

Specimens examined.—BRAZIL: Santa Catarina, Nova Teutonia, various dates 1961–1970, F. Plaumann, 40 ♂, 45 ♀ (USNM). COSTA RICA: Limon Prov., Finca La Lola near Siquirres, ii.1981, A. M. Young, reared ex banana stems, 2 ♂, 2 ♀, 2 larvae, 2 pupae; same but viii.1981, 1 pupa.

Discussion.—This species is set apart and readily distinguished from the other species discussed in this paper by the following characters: The yellow wing spot is much larger, covering the distal portion of the second radial cell; the female tibiae bear an extensor series of prominent pale brownish, slender, pointed, hastate spines; the hindtarsal ratio is 1.0 or slightly more; and the male parameres are much more slender, filiform distally, and have their common base much narrower and fused only a short distance.

The immature stages of the series from Costa Rica will be described later in a paper dealing with other groups of *Forcipomyia* (*Forcipomyia*).

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